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ABSTRACT

Objective and reliable techniques for the assessment of attention deficit disorders (ADD) with and without hyperactivity in children have remained largely unavailable to psychologists, educators and pediatricians. As a consequence, they have tended to base their evaluations of ADD solely on observations and teacher reports, or on measures such as the Wechsler scales, which have been shown to discriminate poorly between groups of hyperactive and nonhyperactive children. A behavioral measure of ADD, called the Gordon Diagnostic System (GDS), has shown considerable promise as a precise, valid and efficient technique for the diagnosis of attention disorders. The GDS contains two measures: the Delay Task, which measures the ability to inhibit responding; and the Vigilance Task, which assesses sustained attention. Research studies have shown that these game-like tasks differentiate accurately between hyperactive and non-hyperactive children. Normative data on GDS performance have been established based on a study of 220 nonhyperactive boys and girls from 6 through 11 years of age. Information on test-retest reliability is also available. (Author)

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# The Objective Assessment of Attention Deficit Disorders

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# The Objective Assessment of Attention Deficit Disorders

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*Objective and reliable techniques for the assessment of Attention Deficit Disorders (ADD) with and without hyperactivity in children have remained largely unavailable to psychologists, educators and pediatricians. As a consequence, they have tended to base their evaluations of ADD solely on observations and teacher reports, or on measures such as the Wechsler scales, which have been shown to discriminate poorly between groups of hyperactive and nonhyperactive children. Over the past 6 years we have been developing a behavioral measure of ADD, called the Gordon Diagnostic System (GDS), which has shown considerable promise as a precise, valid and efficient technique for the diagnosis of attention disorders. The GDS contains two measures: the Delay Task, which measures the ability to inhibit responding; and the Vigilance Task, which assesses sustained attention. In our research studies, we have shown that these game-like tasks differentiate accurately between hyperactive and nonhyperactive children. Normative data on GDS performance have been established based on a study of 220 nonhyperactive boys and girls from 6 through 11 years of age. Information on test-retest reliability is also available.*

## INTRODUCTION

Clinicians, educators, and physicians have been in chronic need of reliable and valid techniques for the assessment of Attention Deficit Disorders with and without hyperactivity (ADD) and impulsivity in children. The instruments that are currently available for the diagnosis of ADD fall into three basic categories: those actually intended for the measurement of other aspects of behavior which have been adapted to assess impulsivity, those which are largely limited to laboratory investigations, and questionnaires.

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Most prominent among the instruments originally designed for the clinical assessment of other behavioral domains is the Wechsler Intelligence Scale for Children-Revised (WISC-R). While selected subtests or groups of subtests from the WISC-R are widely used in the identification of hyperactivity, studies have shown that they do not discriminate accurately between groups of hyperactive and nonhyperactive children (Douglas, 1972). Moreover, those subtests assess a wide range of abilities and traits that are largely unrelated to impulsivity (Douglas, 1972). Thus, while all children with ADD may perform poorly on these measures, there are many nonhyperactive children (e.g., learning disabled, or those with visual-motor deficits) who may also have difficulties with them for reasons other than impulsivity.

Among those instruments best suited for laboratory investigations, the most effective in differentiating hyperactive from nonhyperactive children are the Continuous Performance Test (CPT; Rosvold & Mirsky, 1956), Delayed Reaction Time Test (DRTT; Cohen, Douglas & Morganstern, 1972), and the Matching Familiar Figures Test (Kagan, 1966). While the CPT and DRTT have been demonstrated to be excellent diagnostic measures, their technological sophistication and prohibitive expense make them unsuitable for widespread clinical use. The Matching Familiar Figures Test is quick, easy to administer, and has been demonstrated to be diagnostically sound. However, its reliability and validity have been the subject of considerable controversy which persists despite revisions of the measure (Egeland & Weinberg, 1976).

There are a variety of other measures available such as the Gardner Steadiness Tester (Gardner, 1979), Human Figure Drawings (Machover, 1949), certain configurations of Rorschach indices, and paper-and-pencil "vigilance" tasks. As a group, these tend to suffer drawbacks stemming from impracticality of administration, limited yield of information, or inadequate standardization.

Behavioral inventories or questionnaires have also enjoyed widespread use, and many, such as the Teacher Rating Scale (Conners, 1969), the Child Behavior Problem Check List (Achenbach, 1978), and the Self-Control Rating Scale (Kendall & Wilcox, 1979), have demonstrated good discriminative validity. However, there are serious inherent drawbacks to such a format, including rater bias, the possibility of "halo" effects, item overlap, vague rating criteria, issues of basic validity, and the fact that questionnaires yield no direct behavioral data.

There is thus an obvious and compelling need for a more straightforward, clinically applicable, and precise measure of impulsivity in the child with ADD. The Gordon Diagnostic System (GDS) shows considerable promise as a device which can help fill this gap in clinical service delivery. The GDS is an easily-administered, game-like task which measures levels of impulsivity without interference from other factors such as intelligence or visual-motor skills. It provides objective data on a particular child's ability to inhibit behavioral responding. Through observation of the child's performance and from responses

to several post-test inquiries, important insights can be gained into a child's problem-solving style. This information can have strong bearing on treatment recommendations and educational planning. Thus, the GDS is unique because it yields not only quantitative data, but also a wealth of pertinent behavioral information which is crucial to the diagnostic process.

## DESCRIPTION OF THE GDS

The GDS is a portable, electronic unit which allows for the administration of two tasks. The Delay Task is based upon a Differential Reinforcement of Low Rates (DRL) behavior schedule and requires the child to inhibit responding in order to gain a reward. Specifically, the child is instructed to press a button, wait, and then press the button again. If he/she refrains from responding for at least six seconds, a light flashes and a reward counter increments. If the child responds before the interval elapses then the timer resets and no reward points are recorded. The GDS Delay Task generates three major scores: the number of responses (button presses), the number of correct responses (Rewards) and the Efficiency Ratio which represents the percentage of correct responses.

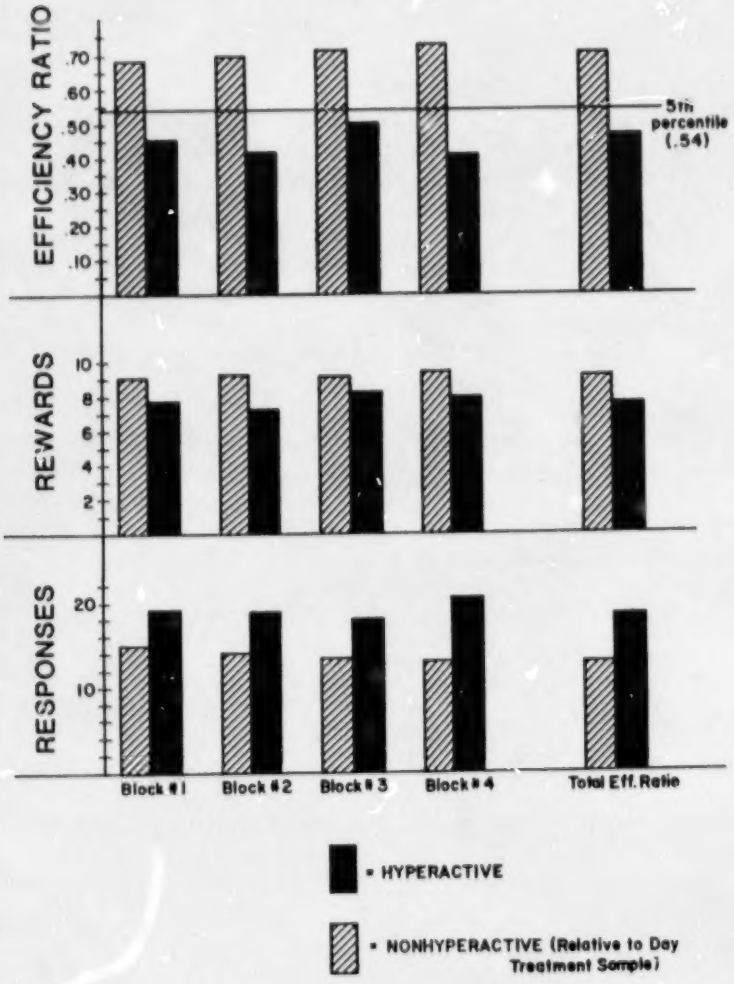
The GDS also contains the Vigilance Task which is a version of the Continuous Performance Test (Rosvold, et al., 1956). The child is presented with a series of digits on the front display and is told to press the button every time a "9" appears that had been preceded by a "1". The GDS records the number of correct presses, the number of times the child fails to press the button when the "1/9" combination appears (errors of Omission), and the number of extraneous button presses (errors of Commission). For testing younger children the GDS contains a "1" mode, which requires the subject to press the button every time a "1" appears. The same performance measures are recorded.

## RESEARCH STUDIES WITH THE GDS

Data concerning the GDS Delay Task come from six studies conducted over as many years. The original experiment (Gordon, 1979), performed on an early version of the GDS, compared 20 hyperactive and 20 nonhyperactive children selected from the patient roster of a child guidance clinic. There were highly significant differences between the two groups for all three Delay Task variables: Responses, Rewards and the Efficiency Ratio (Rewards/Responses). The children classified as hyperactive had profound difficulties in dealing successfully with the delay inherent in the task.

The original finding was recently replicated (McClure & Gordon, in press) with patients placed in a day treatment program for seriously disturbed youngsters. Differences in Delay Task efficiency ratios between the 20 children classified as hyperactive and the 20 nonhyperactive ones in the comparison group were strikingly significant ($p < .0001$).

**DELAY TASK PERFORMANCE OF HYPERACTIVE VS. NONHYPERACTIVE SUBJECTS: DAY TREATMENT SAMPLE**



To further judge the discriminative ability of the GDS *post hoc* analyses were performed with groups constituted on the basis of being identified as hyperactive or nonhyperactive by four criterion measures. These included the Teacher Rating Scale (Conners, 1969), the Self-Control Rating Scale (Kendall & Wilcox, 1979), the Teacher Report Form (Achenbach, 1980), and the Matching Familiar Figures Test - 20 (Cairns & Cammock, 1978). For subjects who were identified as hyperactive (n=8) or nonhyperactive (n=8) on the basis of all four criteria, there was agreement between classifications derived from the GDS Delay Task efficiency ratio and the criterion measures in 15 cases (94%, Fisher's Exact Test, p=.0007). When groups were classified as hyperactive or nonhyperactive by **at least** three of the four criterion measures, there was agreement in 29 of 32 cases (91%, Fisher's Exact Test, p=.000003).

**DIAGNOSTIC ACCURACY OF THE DELAY TASK: DAY TREATMENT SAMPLE**

**Criterion Measures:** **Teacher Rating Scale (Connors, 1969)**
**Self-Control Rating Scale (Kendall & Wilcox, 1979)**
**Teacher Report Form (Achenbach, 1980)**
**Matching Familiar Figures Test (Cairns & Cammock, 1978)**

**Hyperactive Group:** **Identified as Hyperactive on at least 3 measures**

**Nonhyperactive Group:** **Identified as Nonhyperactive on at least 3 measures**

| | Efficiency Ratio | |
|---|---|---|
| | **High (>.55)** | **Low (≤.55)** |
| **Hyperactive (n=15)** | 1 | 14 |
| **Nonhyperactive (n=17)** | 15 | 2 |

**p=.000003 (Fisher Exact Test)**

**There was agreement between the Delay Task Efficiency Ratio and the criteria on 91% of the cases.**

Two additional studies appear to establish the validity of the GDS as a measure of impulsive/hyperactive behavior. In a group of 31 nonhyperactive subjects, GDS performance was significantly correlated with factors derived from teacher ratings. It was also related to impulsivity as measured by the

Bender-Gestalt test and the Rorschach Inkblots. Analyses of data from the files of 32 nonhyperactive outpatient children also indicate strong relationships between GDS performance and parent ratings of impulsive behavior.

**CORRELATIONS BETWEEN DELAY TASK TOTAL EFFICIENCY RATIO AND COLLATERAL MEASURES**

| Day Treatment Sample-Combined Hyperactive and Nonhyperactive | N | r |
|---|---|---|
| Age | 40 | .15 |
| IQ | 40 | .01 |
| Matching Familiar Figures - Latency | 40 | .46** |
| Matching Familiar Figures - Errors | 40 | -.36* |
| Self Control Rating Scale (Kendall, 1979) | 40 | -.16 |
| Child Behavior Checklist Hyperactivity Factor (Achenbach, 1970) | 40 | .33* |
| Behavior Rating Scale | 40 | -.58*** |

| Outpatient Clinic Sample-Nonhyperactive Subjects | N | r |
|---|---|---|
| Behavior Rating Scale (Conners, 1969) Hyperactivity Factor: | | |
| Completed by Teachers | 30 | -.53** |
| Completed by Parents | 30 | -.50** |
| Child Behavior Checklist Hyperactivity Factor (Achenbach, 1970) | 27 | -.44** |
| Bender-Gestalt Impulsivity Score | 29 | .42** |
| Rorschach Human Movement (M) | 31 | .68** |

*p <.05
**p <.01
***p <.001

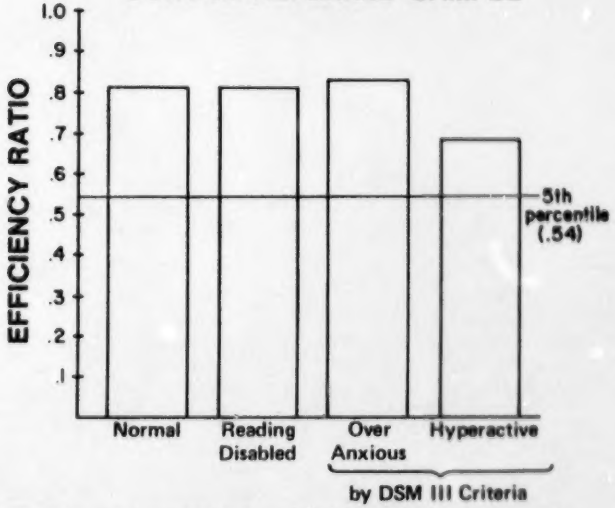
To establish norms for the GDS Delay Task scores, a standardization study was recently completed in the public schools. The sample included a total of 192 boys and girls in three age groups (6-7 yrs.; 8-9 yrs.; 10-11 yrs.). It was determined that the mean Efficiency Ratio for the Delay Task (Total Rewards/Total Responses) was .84 (SD = .13) and that the scores were unaffected by age, sex, IQ and socioeconomic status. As with previous studies, performance remained consistent throughout the 8-minute session. To establish test-retest reliability, half the group were retested after 30 - 45 days, and it was found that the scores remained stable over that period. Norms are also available for the Vigilance Task of the GDS for a sample of 92 boys and girls.

**MEANS OF GDS VARIABLES: STANDARDIZATION SAMPLE**

| | 6-7 year olds | | | | 8-9 year olds | | | | 10-11 year olds | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boys | | Girls | | Boys | | Girls | | Boys | | Girls | |
| Delay Task (n = 192) | M | SD | M | SD | M | SD | M | SD | M | SD | M | SD |
| Total Rewards | 40.0 | 9.0 | 36.6 | 12.0 | 42.8 | 10.5 | 42.2 | 10.4 | 47.3 | 10.5 | 45.9 | 8.4 |
| Total Responses | 52.6 | 15.2 | 47.1 | 17.7 | 53.2 | 14.9 | 52.0 | 14.2 | 54.4 | 13.7 | 53.8 | 9.8 |
| Total Efficiency Ratio | .80 | .16 | .83 | .18 | .83 | .13 | .83 | .13 | .88 | .09 | .86 | .11 |
| | | | | | | | | | | | | |
| Vigilance Task (n = 91) | M | SD | M | SD | M | SD | M | SD | M | SD | M | SD |
| Total Correct | 30.7 | 9.[illegible] | 25.7 | 11.8 | 37.6 | 6.0 | 38.5 | 3.7 | 41.8 | 1.7 | 41.5 | 2.3 |
| Total Omissions | 14.3 | 9.4 | 19.3 | 11.8 | 7.4 | 6.0 | 6.5 | 3.7 | 3.2 | 1.7 | 3.5 | 2.3 |
| Total Commissions | 16.1 | 15.5 | 9.3 | 5.0 | 11.8 | 10.7 | 9.6 | 10.3 | 6.9 | 8.0 | 5.1 | 4.1 |

Also completed recently was a study of 60 children who were classified by the school district as falling into one of four groups: Attention Deficit Disorder, reading disabled, overanxious and normal. The GDS Delay and Vigilance Tasks successfully differentiated between the ADD group and the other three categories. It was also found that the correlations among the Delay Task Efficiency Ratio and the Vigilance Task scores fell in the .6 to .7 range of Pearson's correlation coefficient.

**MEAN EFFICIENCY RATIO: SCHOOL REFERRED SAMPLE**




The hyperactive group had a lower mean Efficiency Ratio than the other 3 groups.

While the GDS has successfully differentiated between groups classified as hyperactive and nonhyperactive, the accuracy of the results is often difficult

to assess because of the absence of reliable, independent criteria for making the classification of hyperactivity. Even when multiple criteria are employed, the degree of diagnostic agreement among the criterion measures tends to be poor. Consequently, when the GDS classifies a child differently, the other criteria may well be at fault. Indeed, when we have pursued such cases with follow-up interviews of parents and teachers, the GDS classification has, with few exceptions, seemed most plausible. (In one case, a girl classified as impulsive by the GDS had been classified nonhyperactive by the teacher's rating. When asked about the child, the teacher responded, "Oh, she's real hyper but she's so darling that I don't really think she's hyperactive.") Our experience to date has led us to orient future research away from criterion-based studies and towards those which focus on behavioral correlates of GDS performance.

The GDS will be further evaluated at 20 research sites in this country and Canada. In addition to expanding our data base, several projects will be investigating whether the device is sensitive to the effects of stimulant medication, while others will be examining the possibility of using it as a training procedure. There is also ongoing research into the possibility of including other tasks into the GDS which will enhance the yield of information.

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